

REMARKS

Objection was made to the phrase "transmitter which comprises a transmitter" in Claims 3-7. This phrase has been changed to "transmitter" as the Examiner has suggested.

Claims 1-2 were rejected under 35 U.S.C. §112(2) on the ground that the phrase "motive device" renders the claim indefinite. Accordingly this phrase has been replaced by the term "position actuator," the term used in the specification for position actuator 32 and position actuator 42. It is respectfully submitted that this amendment resolves this rejection.

Claims 1-15 were rejected under 35 U.S.C. §103(a) as being unpatentable over US Pat. 5,305,756 (Entekin et al.) in view of US Pat. 5,460,179 (Okunuki et al.) Amended Claim 1 describes an ultrasonic diagnostic imaging system which acquires three dimensional image data sets by the scanning of a one-dimensional array transducer comprising an array transducer including an array of transducer elements extending in an azimuth direction and an elevation dimension normal to the azimuth direction; a position actuator, coupled to the array transducer, which acts to sweep the array transducer in reciprocating directions substantially in the elevation dimension; and a transmitter, coupled to the array transducer, which acts to cause the array transducer to transmit a sequence of beams in the azimuth direction, wherein a first sequence of beams is transmitted when the transducer is swept in one reciprocating direction, and a second sequence of beams is transmitted when the transducer is swept in another reciprocating direction. The present inventors have designed and developed a mechanically scanned 3D ultrasound probe which images a volumetric region by sweeping a one-dimensional array back and forth over the volume. The 1D array is continuously transmitting beams in its azimuthal image plane as the array is swept back and forth in its elevational direction (the direction orthogonal to the azimuthal plane.) Consequently, the multiple planes scan the volumetric region as the array is swept back and forth. The inventors discovered that the resultant 3D image has a slight scintillation or shimmering effect, however. Investigation determined that this was due to a slight axial misalignment of the beams when the array was swept in the two opposite directions. The present inventors were able to resolve this problem with the present invention. As the 1D array is swept in one direction, one sequence of beam scanning is employed, *e.g.*, beginning the scan of each plane with beam #1 and ending with beam #128. When the sweep direction of the array is reversed, the sequence of beam scanning is also changed, *e.g.*, beginning each plane with beam #128 and ending with beam #1. As a result, the 3D image was stable without the disturbing shimmering effect.

Entrekin et al. are doing 3D scanning by using beams which are wide in the elevation direction ("fan-shaped") as his Figs. 3, 5 and 7 show. When the sequence of wide beams is transmitted in the azimuth direction, a volume is scanned. Entrekin et al. does not have to move his array to scan the volume and in these embodiments the array 10 is static, it does not move. The only mechanically scanned embodiment that Entrekin et al. show is Fig. 6, which uses a single element saddle-shaped transducer element. Each time the single element is pulsed it transmits the same wide beam. By mechanically scanning the single element back and forth as shown by arrow 54, a volume is scanned.

The beam scanning sequence of Entrekin et al. is not important to them and thus Entrekin et al. mentions beam scanning only briefly. In col. 3, lines 4-5 it is stated that "the beam is steered over the duration of sequential transmissions over a triangular area in front of the array as indicated by sweep arrow 16." This paragraph discusses how Entrekin et al. scan their azimuthal plane, with no mention of the direction in which the beams are scanned and certainly no indication that the beam scanning direction is reversed or changed. And in the only mechanically scanned embodiment, the only embodiment with an oscillating sweep, there is only a single beam because the transducer is a single element array. Thus the action performed by the transmitter of Claim 1, different beam sequences with different sweep directions, is not found in Entrekin et al.

The same is true of Okunuki et al. Okunuki et al. are focused on the way in which they mechanically sweep their array back and forth. They do the mechanical sweep so that the effective pivot point of the sweep is slightly in front of the array (see Figs. 3, 6, and 7) so that they can scan a volume through the narrow acoustic window between the ribs. Okunuki et al. are using a curved array and, like Entrekin et al., the direction of the beam sequence from the array is of no consequence to them. All they say on this point is at lines 57-67 of col. 5, where they say that ultrasonic wave are transmitted and received through a transmitting and receiving surface 26A of their transducer unit, which is the face of their array 28. Like Entrekin et al., the action performed by the transmitter of Claim 1, different beam sequences with different sweep directions, is not found in Okunuki et al. Accordingly it is respectfully submitted that Claim 1 and its dependent Claims 2-7 are patentable over Entrekin et al. and Okunuki et al.

Claim 8 is a method claim which recites the steps of actuating the elements of the array transducer to transmit a first sequence of beams as the array transducer is swept in the forward direction, and actuating the elements of the array transducer to transmit a second sequence of beams as the array transducer is swept in the reverse direction. As just shown,

there is no suggestion of changing the sequence of beam actuation with a change in the direction of array sweeping in either Entrekin et al. or Okunuki et al. Accordingly it is respectfully submitted that Claim 8 and its dependent Claims 9-12 are patentable over Entrekin et al. and Okunuki et al.

Claim 13 is a method claim which recites the steps of scanning a sequence of scan planes from a first side of each scan plane to a second side of each scan plane as the array transducer is swept in the forward direction, and scanning a sequence of scan planes from the second side of each scan plane to the first side of each scan plane as the array transducer is swept in the reverse direction. As just shown, there is no suggestion of changing the direction of plane scanning by an array with a change in the direction of array sweeping in either Entrekin et al. or Okunuki et al. Accordingly it is respectfully submitted that Claim 13 and its dependent Claims 14 and 15 are patentable over Entrekin et al. and Okunuki et al.

In view of the foregoing amendment and remarks, it is respectfully submitted that the informalities of Claims 3-7 have been resolved, Claims 1-2 are now clear and definite, and that Claims 1-15 are patentable over Entrekin et al. and Okunuki et al. Accordingly it is respectfully requested that the rejection of Claims 1-2 under 35 U.S.C. §112(2) and of Claims 1-15 under 35 U.S.C. §103(a) be withdrawn.

In light of the foregoing amendment and remarks, it is respectfully submitted that this application is now in condition for allowance. Favorable reconsideration is respectfully requested.

Respectfully submitted,

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